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Restructuring product development and production networks: Fiat Auto

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Introduction

This working paper is based on research carried out by Ceris-CNR in the context of the international research project on "Product Development and Production Networks: A Comparison of Countries and Sectors" coordinated at the Science Center of Berlin (WZB).
In contrast to other researches on product development and concurrent engineering that has largely focused on performance benchmarking, the aim of this project is to examine organizational, technological and human resource practices that enhance communication and cooperation between the actors throughout the "concept to manufacture" process, with emphasis on the most crucial phases: product development and design, process engineering, and production start-up.
A cross-national study of leading firms in the automobile, machine tool and computer industries of the United States, Japan, Germany and Italy is in progress.
As far as the automobile industry is concerned, the compact car segment has been analysed in each car-maker (segment C). In order to acquire a deeper insight two "vertical slices" have been also selected: the side-doors and the instrumental panel.

1. Company Profile

The Fiat group is the major private Italian firm. The global turnover estimated for 1995 is 76 thousand billion Lira (66 thousand in 1994) and almost 250 thousand employees. The turnover can be broken down into the following activities:

- 68% means of transport with the following firms: Fiat Auto (cars), Iveco (industrial vehicles) and New Holland (tractors and digging machines);
  13% car parts with the following firms: Teksid (iron metallurgy), Magneti Marelli (components), Comau (Machine tools) and Ceac (accumulators);
- 15% diversified sectors, including: aviation, railway, artificial fibres, insurance companies and engineering;
- 4% other services.

The majority shareholders of the Fiat Group are the members of the Agnelli family, who control other financial holdings with interests in most sectors of Italian production, including services to firms and private individuals.
Among these firms Fiat Auto is by tradition the most important. It was founded in 1889 and employs 85,000 staff.
After the two-year crisis period that ended in 1993 and caused a drop in sales equal to 34% compared to 1991, Fiat Auto has made a marked recovery in all areas of the market, thanks above all to an aggressive marketing strategy that involved the launching of 18 new models and investments worth 40 thousand billion from 1991 to 1996.
Despite the slowing trend in sales that has been registered in the last few months, due primarily to Brazil's sudden importation veto on foreign vehicles , where Fiat exported on average 15 thousand vehicles a month, of which 10,000 were Tipo models, the Italian car industry ended the first six months of 1995 on a positive note, despite the poor trend in home and European sales. In fact, compared to the first six months of last year, the total increase was of 11%, whereas in the first half of 1994 it had been of 8.1%.
The growth rate of exportation was even higher, (+23.9%), whereas in 1994 the increase had been 27.3%. The amount exported compared to the national production has also grown. It was 47.3% compared to the 42.3% of the previous year.

The statistics of the first six months of 1995 take on an even greater importance for Fiat if we consider the statistics of the markets. According to the provisional final balance drawn up by Acea, that represents the European car industry, in the first half of the year there were 6,500,300 new car registrations in Western Europe (+1.4% compared to the same period in 1994) and, in particular, 960,700 in Italy (-0.6%). The statistics also show that the Fiat group, responsible for almost the entire Italian production, increased its share. In Europe, its share in the first six months rose to 11.3% from 10.9%. No other group had a greater percentage increase. In Italy, its market share rose from 44.6% to 46%.
Moreover, the Fiat make sold 5.3% more compared to the same period in the previous year. This increase is primarily due to the Punto. The millionth vehicle was made only 20 months after its launch. However, all the new models are contributing to this positive result, from the Coupe' to the Barchetta, and the Ulysse.
Alfa Romeo has had an even greater percentage increase. Registrations of Alfa Romeo cars in Europe have increased by 10.2%. The 145 model has been particularly successful, and in fact, there will also be a "twin" model, the 146; however, the 155 has been far more successful than expected, as well as the Gtv (coupe') and Spider models, both sports cars.
The internationalisation of the product has grown parallel to these increases. The first Fiat world car will go into production in 1996. This model has been designed in different versions, (two or three volumes, station wagon, pick up and van). This model will be built in Brazil (where the Tipo and Tempra are currently being built), Argentina, Turkey (currently producing the Uno and Cinquecento), India, South Africa, Morocco (currently producing the Uno) and perhaps China.
The project is part of Fiat Auto strategy aimed at internationalisation, that is concerned not only with the exportation of its vehicles to many markets, but also with the production of models in about ten countries, by either directly building plants there or by means of joint ventures or license agreements, starting from the mainstays that are Poland, Turkey and Brazil.
Last year Fiat produced almost 900,000 vehicles out of Europe compared to 200,000 in 1990. The aim is to have its business activity divided in the following way: one third in Italy, one third in Europe and the remaining third in the rest of the world so as to create a more balanced distribution and ensure safe development prospects for the firm. This background explains the investments made, that are of varying size (in Argentina they amount to 1,000 billion lira) and the decision to focus on the new markets with advanced models, that have been studied and designed specifically according to the characteristics of the countries where use of the car is in expansion.
Before turning to the analysis of the development process of the new Fiat model for the C segment, it must be remembered that there will in fact be two new versions on the market in September 1995. One is a two volume car, the "Bravo", and the other is a fast back, the "Brava". They are different from the front support up to all the rear part , and some internal finishing touches, including the instrument panel, also differ.
Fiat estimates that sales will total 400,000 vehicles per year.

2. Description of the Product Development Process

Fiat Auto's product strategy has tried to emphasise the different features that are intrinsic of the car, pinpointing the needs of the vehicle as a whole from that of its parts. Such a breakdown has brought about a dual form of management that briefly refers to two functional structures that are different from each other, but that are anyway operatively integrated.
It is the Marketing Department's role to oversee the stages that will lead to the identification of the new vehicle, especially as far as the formulation of the characteristic contents are concerned, (viewpoint of the client). However it is the Technical Department's role to perfect and find new solutions in the development of components (viewpoint of the factory).

The definition of the final product has been considered as the moment of synthesis of these two realities, the meeting point in which the market needs detected by the Marketing Department find answers in the innovative process carried out on each component by the Research and Development Department.
The identification of the development procedures of each new car would not be so significant if it were not seen as part of the global product strategy. In Fiat Auto's case, there are more than 15 models in production at the same time, many of which, owing to the presence of three different trademarks, are operative in the same market areas.
In Fiat Auto, the formalization of the launch of a new product comes within, and must fall in line with, the guidelines made by the so-called Product Range Plan. This plan is devised by the Marketing Department and forms the planning activity for the definition of new models.
The launching times of the new models form part of the plan, as well as the main features and the financing set aside for their creation. Launching data is a fundamental and fixed element, in that any delay could provoke negative repercussions on the introduction of other new products. In fact, some types of vehicles are bound to the seasons, (e.g. Spider, Coupe, cabriolet) or, in other cases, commercial launches carried out at different moments from those established or too close to each other would not benefit the complete and immediate exploitation of market potential.
The current Product Range Plan has been defined for the whole period of the 90's, and has been used in total for the planning of 50 new models (Fig.1).
In the same period and in parallel to the Product Range Plan another plan is devised, but in this case by the Technical Department, the Component Development Plan.
The car, apart from the possible varieties, has been broken down into about 60 components. For each of these components, The Technical Department works together with Technologies, Production and the Purchasing Department. It has the role of defining how a component will be developed in time, with which suppliers and which form it will take in the different models.
The same component, while fulfilling the same role, can be supplied by several external firms and can have different typologies. It is for the team of each plan to decide on which models and with which features each of the various systems or subsystems of components will find a place. Weights, costs, reliability and dimensions must be considered. The starting point is always identified in the needs of the client, whose specifications are compared to the characteristics of the product, the response of the competition and the current and future situation of the market.
Furthermore, development methods must be defined, whether these must be conducted from within, in collaboration with the suppliers, or sent out completely in the case where the know-how is not characteristic of the car product (electronic parts, composite materials, etc.)
By definition, the Component Development Plan is in continual evolution both regarding macro-breakdowns and contents. Therefore one of the basic requisites made to the members of the work teams is the continual monitoring of market changes.
It is intention of Fiat Auto to account for around 70% of the cost of the final product on this activity.
On the other hand, the definition roles of the contents of the product come within the area of marketing strategy. The Product Range Plan, that summarises on the whole the market targets of Fiat Auto, begins to outline the features of the new car long before its launch. In the present strategy, a new model is first conceived by Fiat Auto about ten years before it comes out onto the market. Obviously at the beginning only the macro-tendencies are defined. It can be thought that the model forming part of a specific market area will very probably have a new platform compared to that of a car currently in production, the dashboard will be created using new technologies and materials that have only recently been seen and the brakes will be devised in a different way. As time passes, the amount of information is increasing until it reaches the definition of the so-called archetype of the new vehicle. This happens when the beginning of the definition of the style of the new model in its entirety is defined.
The formulation of the contents relative to the new model comes about in mutual collaboration with the activity of the development of the components, and can be defined as the continual transversal

reading of the different component development plans. In fact, it is precisely the role of these plans to study and create new platforms, new dashboards and new brakes.
On the other hand, it is the role of the Marketing Department to integrate the plan and inform the firms of the planning of the changes on the market that can affect the new needs of the clientele, new technological developments and new laws.
With the definition of the archetype, the macro-definition stage ends and the real concept-planning stage begins.

2.1 Main Stages of Product Development and Time Structure of the Process

The activity of the platforms for the development process of the final planning of a new vehicle begins at the moment when the archetype of the model is defined and ends with the commercial launch. In Fiat Auto this period of time has been divided into 4 macro stages (Fig. 2) and is broken down into ten decision points normally called milestones (Fig. 3) to which 9 points of the planning and systems checks are added (Fig. 4).
The total Time To Market is currently estimated at 48 months, and all the models designed have respected, or are respecting this deadline. With the previous planning methods the time needed from conception to mass production was on average 67 months, that is, about one and a half years more. Fiat Auto has stated its intention to reduce the time needed for the set up of the production of a new model even further. A paragraph will be dedicated to this subject later on.
This result has been achieved by paralleling the activities concerned especially with the engineering and industrialisation of the components that are not seen, developed from milestone 2, and therefore contemporary with the style definition stage. Secondly, the prototype stage and construction of the first pilot models are involved. The so-called spare car are being used more and more in the prototype stage for the experimentation of the components not linked to the stylistic aspect. There is the tendency to build a greater number of prototypes but with a limited number of new prototypal components. On the base of this logic the experiments are aimed at only certain contents, have a reduced global cost and make it possible to obtain much of the information before the completion of the studies. In the final phase of the prototype stage it is possible to carry out the overlapping with the pilot building above all for the repetitive parts that are not subject to further changes. Such parts, that will have to be assembled on the last prototypes will begin to be built using the same productive process that will characterise the final production.

2.2 Short description of development activities in the different stages concerning the slices

The development activities concerning the two components that have been analysed in this research project, i.e. the doors and the instrument panel, show elements that are obviously not homogeneous in the process chain. Despite the fact that Fiat Auto tends to standardise the planning of the various simultaneous engineering teams, it is obvious that the weight in value of the components and the make or buy policies lead to a necessary organisational flexibility. The doors are the component of the bodywork that have the greatest impact on the style of the new models, the sheet metal part is entirely produced in Fiat whereas all the instrument panel is bought out of the firm.
This situation has considerable significance, especially as far as the activities carried out before style definition is concerned, on team composition and the involvement of suppliers and the factory.

2.2.1 The door

As well as the team leader and purchasing representative, the development team was made up of seven representatives for product development (4 people for the metal sheets, 2 for the finishing touches and one for the interior) and 3 for process development (one person for sheet printing, one for the assembly of bodywork and one for plastic materials). The team worked full time and on site from the beginning of the conception phase of the new model. Each week a formal meeting would take place to define the development plan.
The activity carried out before style definition was very intense, in collaboration with the Fiat Design Centre, to ensure the technical feasibility of the aesthetic project. The style project encountered many problems along the way, both regarding the versions, that were four at first- as well as the two-volume and fast back, a sedan and a station wagon had also been planned that were put into segment D-, and the conception of doors, that were initially winding, as they are in the Punto and are now built-in.
This has meant that at certain stages of development there were different concepts being used at the same time on the same components, one that is more traditional and the other more innovative. When the innovative solution was not considered feasible, the study carried out became shelf engineering.
Before style definition, as well as the feasibility of the product and process, the areas that were potentially weak were also analysed, along with the technical solutions of the competition (by buying vehicles or going to the car show-rooms) and the estimated costs of the project were set out with the Technical Department.
The involvement of the factory took place following style approval , mainly for assembly activities, using only one full time representative for the whole body-work area, and some specialists called in to solve particular problems in an intensive way during pilot production.
Four suppliers were involved in the co-design activities- one for the panel, one for the rubber lining, one for the windows and one for the window regulators- and began operating after the feasibility studies and style approval. None of these people carried out resident activities.

2.2.2 The instrument panel

The activities carried out by the instrument panel team are very different from the activity of the doors in that they depend on the buy strategies devised by Fiat for this component. Not only for the degree of purchasing (100%), the number of suppliers (an Italian supplier of the Fiat group and a Japanese one), the number of different versions (three according to the market area), but above all for the decision to set up co-design contracts that are parallel to the parts in common for both, and at different times, (the Italian supplier has the bottom end of the market, the Japanese supplier has the top end of the market and they both have the middle version that will be produced in the greatest quantity.)
The Japanese supplier was involved right from the feasibility studies before style approval for research with the Design Centre into the possible alternatives regarding style and the needs of the client in connection with the other parts of interior design. The collocation and resident activities with the suppliers (on average two for both of them) only began after definition of the style.
Despite the understandable difficulties in running two parallel suppliers in co-design, a positive atmosphere of collaboration and synergy was created between them.
Because of the peculiarities of the component, all the Fiat representatives in the team took a part-time role, focusing on the system activities: the team leader came from the Technical Department and also carried out other activities in the platform, there was a process designer for assembly problems and a purchasing representative. Another purchasing representative was introduced at the

beginning of pilot production with the role of inspector of production on the suppliers' premises and a constructive collaboration began with the factory; until that moment the process designer had been the link with the plant.

2.3 Relevance of the time-to-market pressure in the industry and the companies investigated

The compacting of Time To Market was faced by Fiat Auto in a very direct way: first the activities/stages influenced by the definition of the style and worthy of the greatest attention were identified and separated from those concerning the development of the chassis, (mechanic plus floor of the body), whose study can be almost freely anticipated. This has enabled a considerable demarcation in the number of designs that need great attention.
The example refers to a product formed by about 3,500 designs: just over 1,500 of these are linked to style definition and therefore must be managed within the Time To Market limits; on the other hand all the others can be followed with a greater freedom, giving the advantage of an easier management, fewer development costs and more limited risks, especially at the most crucial points.
Moreover the experience accumulated over the other developed models, and in particular, project Bravo-Brava, have shown the need to focus attention for future models on the aspects described below.
Planning will take 1.5 months less thanks to the use of the CAS technique (Computer Aided Styling) that produces a mathematical model of the style model from the conception of the drafts, eliminating the importance and subsequent mathematising of the form after approval.
For the further reduction in the planning activity of 15 days, work can be done on the groups/subgroups influenced by the definition of style, that exceed the aim by 6 months, that is, body side, complete dashboard and doors.
The possible actions are:

- use of a greater number of resources, operating in group or at a distance, where the activity can be divided further; for example, on the body side it is possible to make up to 8 people work at the same time;
- use of double shifts where the activity cannot be divided into two or more parallel activities that can be assigned to two or more people;
- rationalisation of work distribution, assigning leader suppliers with the study in co-design where they are completely responsible for the units that are more and more integrated in order to simplify management and interfacing problems.

It is obvious that a type of activity like the one described above means that the firm must be given standards, both in technical solutions and in procedures, suitable means to operate at a distance, and that the people forming the planning team must be adequately trained. The suppliers of subsystems must also have been trained in order to provide adequate support for the time needed and must therefore be integrated with the car construction company in a very close working relationship.
The operating method described above can be more expensive and must therefore be applied only in cases when process times require them and after having established its worth after a study of the financial situation.
The same concepts illustrated concerning the planning of the product can be applied to the industrialisation process, from the subdivision of the dies and the equipment in the two associated assemblies to designs dependant or independent of the aesthetic definition, to the application of the artifices suitable for the acceleration of the work with overlapping or double shifts.
The groups that still require longer times to equip are bodysides, doors and dashboards. The reduction by 3 months in the industrialisation times previously estimated can be obtained by:

- the study of the die parallel with the definition of the product;

- saturation of the numerical control milling machines that exist inside and in the store of the suppliers;
- reduction of the adjustment time thanks to the calculation simulation of the plate-stretching and the flow of the plastic material in the die.

However it is easier to save time during the last part of the development process that in some cases is still rather long. For example, at Fiat Auto, Time To Market has process checks 14 months after the launch, that is the building of a few tens of cars at the pilot plant.
Another moment where it is possible to save time is during the productive rump up, that the Japanese car makers achieve in reduced times (one month or slightly more), whereas in the West at least 3-4 months are taken.
Fiat Auto considers the complete elimination of the process check and the reduction the times of productive rise to the values of best practice possible, by means of a hard-line organisation and process development management in activities backward, so as to reach the concluding phase with the final design release that has really been respected in the contents and quality of the documentation. In fact, the definite parts of external or internal production can be available at the established times only on these conditions, both for the quality and quantity required.
Lastly, it must be pointed out that the experimental checks on the prototypes have not been mentioned as being part of the critical process. In fact, the computer simulations, the bench tests on components or dummies or parts of subsystems, give a good guarantee of being selective and suitable to show immediately any possible critical phases, so as to guarantee that the final certification on the pre-series cars will show a result that is in keeping with the aims.
A further considerable reduction in the Time To Market will be technically possible during the next 5-10 years with the logical organisation in data banks of the information necessary to create a "guided" planning, both for the product and the process associated to it.
More clearly, they can imagine having gathered in data banks the archetype of the ideal vehicle combined with the process associated with it, both integrating the best predefined and standardised solutions.
Once the style has been approved, the project can be concluded in a very short time, by simply adapting the archetype to the external form using CAD. At the same time the system will determine the new parameters of the construction process.
In the scenario that it has been described, the Time To Market could be reduced by a further 6 months or perhaps more.
To make this process easier, new network planning techniques will be adopted in substitution of the Pert model.
To make time to market easier, it is necessary to clarify the aims in a concluded way during the set-up stage, focus on the carry over, on the mathematical checks, create the prototypes as soon as possible, and carry out the greatest number of activities possible. In this case especially, the greatest benefits could be obtained, but it is necessary to develop a powerful information system in order to achieve these results.

3. Organisation of the Product Development Process

In Fiat Auto the Technical Department has the responsibility for the development of new cars. Its staff is made up of about 3,000 people, managers and workers, and its main offices are at the Fiat Mirafiori plant in Turin, and at Alfa Romeo in Arese.
Along with the Purchasing, Production and the new Environment and Industrial Policy Departments, the Technical Department works within the Central Industrial Department, and is organised in working sectors, each specialised in a particular aspect of car planning.
At the end of the 80's, during a time when in fact Fiat Auto did not have any problems with market share, a wide comparison with the most important car makers was made, especially with those that

had managed to recover from a crisis period. The organisational changes began precisely from these comparisons that emerged from the research.
To favour Fiat Auto's adoption of a new style of management and the passage towards a more flexible organisation aimed at continual improvement, 20 strategical projects were defined in 1991, that were the basis of the Total Quality Project.
On the whole, the new set up of the Technical Department is structured in such a way as to work using two different methods that are at the same time interactive.
On the one hand, in the horizontal sense, there is the management of the projects that follow the development process of the new product, so that times, contents, costs and quality aims defined in the creation of an archetype of the new model established by the Product Range Plan (platforms) can be respected.
On the other hand, in a vertical sense, the sectors of the Technical Department will have to guarantee the know-how of the resources: labour, means and technologies. Moreover, the contribution towards the creation of the new vehicle takes place also by creating within in certain parts of the vehicle according to the points established by the Component Development Plan (for example, the engine).
Therefore we have the formation of a matrix structure along the product lines that correspond to the various market segments (platforms) (Fig. 5).
The organisational set up is based, therefore, on a dual articulation:
- control the process to reduce times, costs and guarantee the integrity of the new model;
- oversee the know-how of the projects to ensure quality and innovation.

3.1 Relation between functional and project organisation

The role of the platforms is to bring to production the model established by the Product Range Plan in the shortest possible time and with the best results, regarding quality, costs and performance.
As said in the previous paragraph, the platforms are functionally placed within the Technical Department, and the reason why is basically due to the fact that one of the roles of the sectors of the Technical Department is to make available for the platforms:
- human resources, having been suitably trained so as to have the professional skills necessary to carry out and achieve future goals. The designers belonging to different teams of the platforms in fact come from these sectors.
- The testing equipment on the road and on the shop floor in such a way that the platforms are able to compare the results obtained with the aims established for the new model.
- The calculation procedures and all the relative codes necessary for the development of the projects and for the experimentation methodologies. All these activities that are centralised in specific structures in such a way as to define the same calculation criteria for all the sectors.
- CAD instrumentation (Computer Aided Design) to design and enable the creation of dies and all the equipment necessary for the production of the details with CAM (Computer Aided Manufacturing) technologies.

To bring the required model into production in the shortest possible time the platforms must limit their work to the application of the components and not to its complete development. Therefore it is the role of the sectors of the Technical Department to make available the greatest number of components that will be assembled on the new model. That is to say, give the components that have already had technical approval and that are practically adaptable on a vehicle being developed.
Finally, the Technical Department must co-ordinate the different platforms in the areas that are irrespective of the individual platforms and individual model. The contemporary activity and the rapid succession of development plans of new models have highlighted the existence of determining aspects, that can be the acoustic comfort and the passive safety of the vehicles that involve the whole vehicle system, and that therefore cannot be studied within a specific function,

and that at the same time affect several models being developed. This need emerged following the introduction of the platforms, and has been faced, since 1992, by the creation of so-called "transversal plans". Fiat Auto considers the number of transversal plans between platforms a good estimation of the internal Communication.
Transversal plans are projects where the sectors of the Technical Department must help the platforms to bring into production the components that must be applied at the same time to all the vehicles. This is the meaning of transversality, because should the application on the various models take place at different times, the internal technical memories could be consulted. Instead, a common and immediate need emerges, as might have been the air bag, the pretension of safety belts and the accelerator sensor, and this leads to the guarantee that the component will be chosen by everybody according to the same characteristics, and that it will be applied by everybody according to the same specifications and that the problems found during the application on the model will not be repeated in other projects. The lack of a co-ordination in these contexts could result in the repetition of the same error, forcing several people to find the same solution thus causing a waste of time and financial resources.
The transversal plans represent therefore, a new dimension in the matrix organisational structure adopted by the Technical Department, and turn out to be a useful instrument, especially in order to reply efficiently and quickly to sudden changes in the market.
There are many meeting points between the structure of the platforms and the functional structure of the Technical Department. As well as the formal and informal contacts between the Component Development Plan (Technical Department) and the Product Range Plan (Platforms), a specific professional figure is created within the organigram of the platforms, who has the role of representing the sectors of the Technical Department. This figure does not have the task of controlling or protecting particular interests, but is a technical reference point for the team leaders during the development of the new vehicles, like a know-how source. As well as this, this professional must also organise the basic set up during style definition, and identify the directives that characterise the new model.

3.2 Project Organisation

Five operative platforms have been created for the set up, planning and management of the changes of the new Fiat Auto products, one for each product area.
The identification of the platform has a technical source in the platform of the vehicle that even if it is not completely respected, identifies a series of products that have a high level of techniques in common. A specific organisational structure is configured on the basis of the platform that must oversee the development of all the models that are represented within this grouping.
For the grouping of these activities Fiat Auto's organisational model stems from the Technical Department and is characterised by a three tier structure with command elements and cascade management, along with a greater assignment of the capacity to delegate, give responsibility and autonomous decisional powers of the inferior levels (Fig. 6)
The superior level is defined by an organisational procedure with a matrix structure where in one of the two dimensions the units of the Technical Department are found, and in the other, for each of the 5 platforms, the other functions are found. However it must be noted that within these interfunctional teams, the Technical Department has kept a strong, predominant role.
It is not by chance that the Platform Managers all come, except one, from this role.
The resource dedicated to the platform has been structured in different project teams. Each team has been given the task of developing a particular subsystem of the vehicle.
The core team has been designed to be stable. One of the major activities of the core members is the co-ordination of the platform activities that are assigned to a management level of each vehicle,

and, within this management, the specific component. Its action does not end with the one product, but co-ordinates the activity of all the models in the platform.
Thus the core team is composed of: Platform Manager, Product Manager, Process Manager, Procurement Manager and Finance Controller. The *Make Supervisor* also comes from the marketing area, and has the task of directing the external communication processes, evaluating the parameters and the programmed performance and supervising the specifications of the various makes.
The Procurement Manager and the Process Manager are the members of the set- up team who interact the most with the Platform Manager. They are linked functionally to the Platform Manager even if a hierarchical dependency does not exist. Also the Product Manager's role is of extreme importance, in fact it guides the members of the platform from the zero stage to the style approval.
Together with the Procurement and Process Managers, but with a hierarchical dependency on the Platform Manager, there is also a Vehicle Manager present in the core team, one for each developing model, who must follow the technical project aspect, in order to guarantee the production of technical material, technical suitability of the technical solutions and the overcoming of weak points.
Generally speaking, the Platform Manager has a hierarchical level rank higher than the other managers of the core team.
Within each platform, there are in fact several vehicles, usually one or two per trade mark typology. For each model being developed, a reference subteam is created that mainly repeats the formation of the core team. Therefore, for each model we will have a representative for each of the figures previously listed. The Vehicle Managers, representatives of the Platform Manager, will interface with the *Marketing Assistant,* representatives of the Product Manager, with the Procurement Assistant and so on. Delegation is not so net between managers and their assistants in this team work.
Towards the end of the project development the *Factory Manager* can also be inserted into the work group. The Factory Manager intervenes especially during the pilot stage of production and when specifically asked, above all if the vehicle is made in a plant with several models. Also the *Sales Manager* is introduced towards the end of the project. He tends to start operating 9 months before the launch and in a certain way takes on some of the tasks of the other representative of the marketing area, the Product Manager, who had followed the development process of the new vehicle since the definition of the archetype of the model.

3.3 Simultaneous Engineering Teams

A third underlying organisational structure emerges from the Vehicle Manager for projects that involve the formation of temporary organs, each of which are responsible for the execution of activities that are particularly complex and that require the use of several people coming from different company functions.
In each of these planning groups a team leader is appointed by the Vehicle Manager and the functions, who co-ordinates, according to the modalities of simultaneous engineering, the activity in collocation with the product and process design and the other functions involved. The opinion of the production team leader can also be required at this point, who will have to produce that particular detail of the vehicle.
During the development of the Punto, Fiat Auto reached a rationalisation of the development process of a vehicle. The new projects have been divided into 16 basic teams, active in physical subsystems (suspensions, dashboards, etc..) and in a further 3 teams, whose work task is made up of performance and characteristics typical of the complete vehicle system, (lay-out, bodywork, finished vehicle). The number of interfunctional teams vary according to the project. For example, for the Bravo-Brava, there were 21 + 9 established teams because two different versions had been

planned from the beginning (5 doors, 3 doors). In the figure 7 it is possible to deduce the prospect of the basic team.
The composition, dimension, assignment of tasks and the division of labour vary according to the needs of the moment.
The skills and targets the team leaders must reach are defined by the Platform Manager and Vehicle Manager together. Usually the same team leader is kept throughout the life of the project.
The presence of representatives of the sectors of the Technical Department exists in a transversal position to the team leaders. There are 5 managers in all, divided into the areas of body, electrical equipment, engines, chassis, and finishing and, if necessary, they can take part in the activities of the teams of engineering/industrialisation to ensure a coherency with the definite set up.
If the total management of the teams is run by the Vehicle Managers who must co-ordinate all the planning and experimental type activities on all the components that go to make up the new vehicle, it is the responsibility of the Representatives of the sectors of the Technical Department to monitor each individual subsystem, taking part in the core team for the definition of the targets for the relevant area in coherence with those of the product.
The difference between these two figures is not only one of area, but it is also fairly substantial. In fact, the Representatives of the sectors of the Technical Department limit the area they are involved in to regard only the technical , and not the technological aspect. They are figures of a purely technical use, and for this reason fall within the sectors of the Technical Department, and do not have the transversal functions of the Vehicle Manager.
The team leader is a professional leader that has only recently been introduced in Fiat Auto, with relatively new tasks, and different from the project methodologies prior to simultaneous engineering. In the planning for functions, a project leader was appointed within the structure to co-ordinate a dozen designers in the development of a particular macro component. The present team leader comes professionally halfway between the previous project leader and the ordinary designer. The professional contents are different both because a greater project knowledge is required, in that the team leaders were former designers and therefore the presence of representatives of the sectors of the Technical Department in the platforms is essential. These representatives of the sectors of the Technical Department are none other than the former project leaders. The other reason is a new capacity of interfacing with the other company managers present in the team.
The co-operation between the teams that are interfunctionally active on different models or platforms is not specifically included. Dialogue takes place for the make or via the representatives of the sectors of the Technical Department.
On the way of the Bravo/Brava it is also emerged the role of the representatives of the sectors of the Technological Department for assembling and pressing. Their role it is similar to the Technical Department ones, but it is still less defined.

3.4 Interface Problems between Project and Functional organisation

Despite the fact that the majority of the functions exist within the platforms, that does not exclude the possibility of friction between them. Obviously the use of platforms makes problem solving easier, and more importantly, anticipates them, but it is definitely unable to avoid all disagreements. It is no surprise therefore that the most critical comments on platforms have come from people outside them.
Platforms are a relatively recent organisational instrument that has changed the internal distribution of power. However, this does not exclude the necessity to re-configure them on the basis of the context in which the platforms have been introduced.
Fiat Auto's new organisational structure has been supported by a series of actions aimed at giving a wide visibility and at highlighting the new operative method; direct intervention of company management and collocation are clear examples.

However, an opposing effect can be found. There has been a depreciation and minor perception of the value of the activities carried out especially within the sectors of the Technical Department.
The most typical development activities of the know-how of the resources and more generally of the sectors of the Technical Department have been and risk being reduced.
According to the organisational units involved, three different relationships of difficulty in the communication and co-operation for the development of new products can be currently identified: those concerning the internal conformation of the platforms, those concerning the Technical Department where the platforms are placed, and those concerning the other functions in general.
Despite the fact that, as the people interviewed have stated, communication and co-operation within the platforms have been widely recognized and are the subject of continual study, preferential relations undoubtedly exist dictated by the necessity of the moment or situations embedded in company culture. These relational factors are not by chance and follow precise rational behaviour.
On the basis of these suppositions, of evaluations that have been carried out in each stage of the development of the project, on the reciprocal involvement of each component of the core team, an effort has been made to highlight the specific characteristics of the interdependence present in the platform of Fiat Auto.
The results in figure 8 and 9 are obviously reflections on the data obtained[1].
In the case of internal relations a greater variation has been noted, and this has enabled the identification of different situations of interfuntionality, as far as external relations are concerned. In fact, the opposite has happened, for more stable relations have emerged[2].
The only different interpretation in the figures is due to the representation of the intensity of the co-operation. A minimum level of interdependence exists at any stage between the members of the core team, that our interviewees have always declared but has not been shown graphically for simplicity. With regards to external partners, however, if no arrow has been included, it is because no interrelations have been declared.
In particular, as far as the collaboration between the Technical and Marketing Departments is concerned, it emerges that if the relations of collaboration from the problematic aspect and not from the conflictual aspect are meant, the maximum of attention is placed in order[3]:

- in the evaluation necessary to develop the new products so as to adapt the needs of the client to those of the planning;
- the absolute impossibility of postponing the commercial launch after the date has been announced;
- in the evaluation of the need to solve particular problems. It is a fact that marketing is particularly volatile in the definition of targets and that project development cannot put up with continual set up changes;
- in the reduction of the time necessary for the conception of the new product. In the previous situation more than 6 months were necessary. Currently the value has been reduced;
- less importance given to the set up specifications and the changes in that a wide and complete sharing and justification of the proposals exist.

The graphic representation of figure 8 fully highlights the continual link between the Technical and Marketing Departments.
During the engineering and industrialisation phases, the Technical Department actively co-operates with the departments of the product as well as with the industrial ones. In this stage the department of product Quality forms bilateral relations of medium intensity with the purchases and

1 For example, is there is a contrast between the Technical Department and the Purchasing Department where one has declared a very high exchange of information during the conception stage of the product whereas the other has declared the opposite, the relation was considered to be of medium intensity.

2 For this reason it has been possible to carry out a sole total ** for each product development stage.

3 Integration with the product will be investigated further in point 5.

technologies, interfuctional relations that in future will be intensified and broadened to include the Experimentational vehicle too.
The importance of the platforms as a bonding factor between the functional areas involved in the development of the product is further confirmed by the fact that all the components of the core team have declared that on average 70-80% of the informative flow takes place within this structure, whereas the other forms of contact turn out to be computerised systems (10%)[4] and less importantly written communication and telephone conversations (5% for each).
Another element that shows the importance of platforms can be linked to the nature of the necessary documentation to begin the activity of each component of the core team. Such documentation, as well as defining the aims, according to the interviewees, clearly and without producing potentially wrong interpretations, emerge mainly from within the platform and therefore are able to anticipate the needs of the functions that will use them in future.
The advantages obtained are not only identifiable in terms of time, costs and quality, but can also derive from a better use of the organisational structure. For example, our interviewees declared that hierarchy can be both a drawback to communication and co-operation only with regards to two departments[5].
If we consider that hierarchy, together with distance, that in Fiat Auto have been to a great extent eliminated using collocation, are generally thought to be a source of efficiency and the prime obstacles to interfunctional co-operation, we can understand more accurately how profound a change has taken place.
This does not mean that all the problems have been solved. The fact that the main causes of disagreement between the various functional areas, stated by our interviewees, depend on the clarification of the adaptation of the respective targets, on the attempt to maintain the bureaucratic aspect of the relations, on the presence of technological incompatibilities, show the lack of a sufficient shared space of agreement and a mutual understanding of their respective needs.

3.4.1 Management of the internal and external conflicts

The orders given by the Board of Directors for the development of the process concern the respect of the quality targets (aesthetic characteristics, performance and content), time, costs and investments in technologies. They can concern the respect of the feasibility, of the times, of the costs, of examples of management for the creation of the final product (e.g. management of the variations: to satisfy all the versions of the Bravo-Brava C 260 different bumpers and 266 rear-view mirrors are planned).
The instruments and documentation used to ensure that such orders are followed are:
- The Initial customer perception (drawn up by the Marketing area);
- the Quality profile (drawn up by the Marketing area);
- the breakdown of the development costs (drawn up by the Technical and Planning Departments)
- the Design Reviews (drawn up by the Platform Manager) are advanced process checks that must contain the length of Time To Market.

The functional scale for the solving of internal and external contrasts of the interfunctional work groups directly involves according to the gravity of the problem: the team leaders, the

4 With the complete development of the CAD model it is thought that the communicative flow through the computerised systems can double.

5 On the whole the contrasts mainly concern the technological incompatibilities during the changes, the lack of workforce and the changes that have taken place during the reconfiguring of the product.

Representatives of the sectors of the Technical Department, the Vehicle Manager and lastly the Platform Manager[6].
There are various levels of conflict that can be in this order:
- Minor disagreements are solved in person by those in charge or within the team with the Vehicle Manager.
- For more serious contrasts on the evaluation of the qualitative characteristics the so-called Jury Tests are formed within the platform. The evaluation takes into account the dual threesome Quality-Times-Investments.
- Responsibility for co-ordination between functions falls on the Platform Manager.
- The Board of Directors deals with contrasts concerning times and the operative plan.
- In the case of new interventions, (for example motorisation for newly-qualified drivers) the Marketing Department or Board of Directors is called upon, depending on the importance of the change.

The crucial moments that are mainly kept under control concern the losing sight of the established targets. There aren't any serious problems with the sectors of the Production Department. Some contrasts may arise with the area of product Quality and marketing (Product Manager) who represent the market and the opinion of the client.
The results achieved are recorded on paper and given only to the people involved. 75% of this data is recorded.
Every week half a day is devoted to the evaluation of the progress stage of the vehicle by the different Representatives of the sectors of the Technical Department and the Platform Managers.
The old concepts bound to functional organisation still exist, therefore it is not uncommon for hierarchical conflicts to arise with the functions. This turns out to be a waste of time, worsens relations, and proves to be a lack of attention to the creation of undesired costs.
Those who are in the platform absorb a tendency to aim their intervention at a successful outcome of the project-product more easily and does not limit its field of action to the interests of function.
Problems regarding work areas between the platform and functions occasionally arise and are often connected to the people who work part time with the platform.
Reluctance on the part of the functional supervisors basically depends on the person or type of company. However, it is usually an exception rather than a common recurrence.

4. Supplier Involvement in the Product Development Process

4.1. Degree of Outsourcing

The percentage of the value of Bravo-Brava components developed by supplier in co-design is 59%. Fiat intends to increase the number of components developed externally to 81% for future models. As far as the percentages of components purchased by suppliers are concerned, the percentage in number is equal to 79%, value 69%.
If we consider that in all its history Fiat has intervened on all but three details; windows, batteries and tyres, it is easy to appreciate the extent of the re-organisational plan.
The tendency is to make Fiat Auto become an integrator that focuses only on the production of certain parts that are thought to be strategical, purchasing pre-assembled components and regarding suppliers as development partners to a greater extent.

6 Excepting problems of a technical nature, it has been stated that contrasts between the project team and the subordinate teams have never arisen.

Apart from suppliers of metal sheet, the top ten most important Fiat Auto suppliers are all development partners.
The suppliers are classified according to evaluation parameters established by three company departments (e.g. Technical, Quality, T.T.M. Service).
The Purchasing Department sets out and updates rationalisation plans per product lines on these bases, with the view to the best compromise between Fiat Auto's needs (in their development) and the number of presences, productive placing, standardisation, etc.
The choice of suppliers is made by the Purchasing Department and shared in the Platform with particular reference to the technical/technological aspects regarding the product.
In Fiat Auto there is a Board for Diverticalisation regarding the degree of strategy, with the role of defining the make/buy strategical activities and of evaluating any variations in the operative activities. The Board meets regularly and reports back to the Company Head Office.
The aim is to reduce the number of suppliers to 320, and establish a direct relationship with them, purchasing pre-assembled modules.

4.2 Simultaneous engineering activities with suppliers and engineering offices.

Suppliers have a very important role at all the levels of planning activity. In fact, organisational change has not only involved the internal process of the firm, but also the external process that regulates relations with suppliers.
Within the activation of a widely extended diverticalisation strategy, Fiat Auto has asked the suppliers for a greater involvement, exceeding purely operative execution. Thus suppliers have already begun to contribute in the lay-out stage of the product specifications, and can be included, full-time, in the team work, so as to safeguard the best use of their component.
With the platforms, the operative flow has widened as well as changed. The greater involvement of the suppliers has given them attentions and complexities. Two suppliers of Fiat Auto, one foreign, and an Italian one, have even organised themselves in platforms.
The evaluation of the suppliers on the basis of their integrative capacity, varies according to the speaker.
In particular, the greatest number of conflicts arise due to technical incompatibilities, in qualitative controls and reaching fixed goals.
The strong diverticalisation process means that attention is focused on the principles of transparency, crucial moments, collaboration and team work.
Once the suitable supplier has been chosen to produce the part in question, the collaboration process begins. The space allocated in the platform to the supplier is large from the style approval : they are an important part of the interfunctional teams, and for the duration of the work together, have all the data regarding the performance required of the component (reliability, weight, bulk.....), of the details of the product, as well as desks, telephones and necessary work instruments, as for example CAD stations[7].
The co-design work enables a reduction in planning times for both parties. In fact, as soon as the pre-studies are ready, the suppliers can begin the lay-out of the design which they are entirely responsible for. Once, on the contrary, the supplier must wait for the final design from Fiat Auto, and then adapt it to its own technologies: this meant a waste of time and efficacy in terms of unsuitable solutions to the needs of Fiat Auto and the supplier. The shared work also continues during the pre-series check stage and therefore eliminates the risk of carrying out modifications at the moment of production.
The greatest degree of delegation and responsibility given to the suppliers means that there is a greater involvement in the final result to the point that they carry out bench tests themselves on the

7 They have also use of the internal canteen service.

single detail or systems assigned to them. Consequently, Fiat Auto limits itself to checking only the compatibility of the details with the vehicle as a system.
In fact, the development partners receive at the same time:
- the set up studies
- the qualitative and product specifications
- target costs
- times

The level of the design specifications depends on the typology of the detail and supplier. If the supplier ranks among the leaders the specifications become only the essential ones.
The change that has taken place means that the old systems of collaboration have not been used, particularly those linked to the representation of individuals.
Parallel to the adjustment of co-design, Fiat Auto staff have been transferred to the supplier firms to face the increased workload and the need for know-how that co-design requires. This last factor has also favoured the creation in shorter times of the necessary synergies for co-design work.

4.2.1. Communication and co-operation structures

A far from perfect relationship can still be found with certain suppliers. Such situations depend largely on the way supplier relationships have historically been made. In the past, in Fiat Auto, there was the tendency to very carefully set out the details of the product and the expense specifications, and only the suppliers who were able to offer lower prices at the same level of quality/service were used.
The present situation has changed in that there is the tendency to involve the supplier even in the planning stage.
In fact, there is clear difference between those taking part in the co-design and those who are not. For the car makers, co-design means taking certain risks because in this way there is a greater dependence on the supplier, but nowadays this is a forced choice and there are no valid alternatives.
It is thus necessary for the suppliers to take on a proposing attitude, a new operative mentality, and for them to take risks themselves, deriving from the creation of the project. It is a decisive challenge for Fiat Auto because for years the supplier has been seen as having an inferior position.

4.3 Contracts

The definition of contracts with suppliers is certainly one of the organisational structures that has been changed the most, affecting any relationship between them.
First of all, the procedures have recently been changed. The contract is not made solely by the Purchasing Department but together with the Platform. In fact it is the Platform Manager who signs any agreement made.
The drawing up of the contract, even if it is in co-design, takes place during or even at the end of the development stage and includes each part of the product details: first and foremost the qualitative standards, costs, weights and development times.
The delay in the wording of the contracts was considered as being a strong limitation to co-operation between suppliers especially by members of the slices. This was because the respective responsibilities were not immediately defined (e.g. whose job it is to transcode the CAD data if the systems are not homogeneous) and the certainty of the supplier to offer complete collaboration is therefore reduced.

The choice of supplier is not always made quickly enough, and this should happen as soon as possible for everyone, right from style definition and the feasibility studies. This way, the ability and responsibility of the supplier would be put to the test and ascertained.

4.4 Consequences of Outsourcing of Product Design, Die Design, Manufacturing

Three more problems arose during the development in co-design. The first two problems concern all the suppliers, whereas the third mainly concerns small Italian firms.

- The Fiat experience found the suppliers lacking in sensitivity regarding the border areas between the components. The focus is more specialistic and less of the system. In this case the car maker must probably make a greater effort in defining points of contact;
- the principles of mono-supply have not always turned out to be efficient. In some cases a greater level of competitivity could be considered necessary;
- many suppliers are able producers but are not so skilled at planning. In many cases they are completely lacking and therefore make use of external engineering studies that in fact form an intermediate step and make the information flow between the client and the supplier difficult.

5. Integration of Manufacturing in Product and Process Development

At Fiat Auto the major topics of discussion on which collaboration relations between the Technical Department and the productive departments are based are currently: the productive feasibility of the product (maintenance of the calculated figures in the engineering stage) and the respect of timing especially at the moment in which the changes to the initial project have been made. This maintenance is valid in all the stages where the sectors of Production are directly called upon in the creation of the new product. That is to say, the experimental product, the pre-series and mass production. In some rare cases these problems arise concerning the interfacing between the different operative systems.

The point of view of Production is of great importance for the fact that the basic philosophy of Fiat Auto until a few years ago was mainly based on production. Obviously, a lot depends on the representatives and their mentality. However, on this point, the new organisational set-up has brought about a reduction, in a relatively short period, of a large part of the barriers that existed between the two functions. For example it is clear that the core team will carry out some of its operative functions in the place where the production itself will be made. Moreover, the logic of the integrated factory on the one hand and simultaneous engineering on the other have brought about an involvement of the plants from the moment of product development where the equipment is adjusted.

In the previous set-up the systems and the equipment were not defined in detail, the production cycle was described in a general way and was not even formalised. In fact it was the factory's duty to arrange it with the high risk that it would not completely meet the set-up criteria.

Now, however,, the start-up stage of production is carried out by the transferral of the product development teams along the productive lines, where the designers, technologists and suppliers work together with the line workers to solve the problem of productive activation. The cycles between them must be completely defined, respecting the initial logics and intervening on the product, if necessary, to make industrialisation easier or to solve any possible logistic problems.

Simultaneous engineering logic is expanded in this way to all the stages. Productive activity is a modal stage. Many of the problems arise precisely when the production of products in line is attempted: problems with supply, staff training, product problems, problems with technological feasibility, etc. The presence of the development work team during the perfectioning of the process

enables a solution to be found in a short time that formerly and traditionally took months, in that the factory had to make the problem known to the technologies, and if it failed to solve it had to involve planning, without considering the fact that while the people who had established the work might have been transferred and the problem should have been solved by others.
Co-operation in general and especially co-operation with production is, therefore, fundamental.
The management of pilot production takes on considerable importance. The first perfectioning of the process during this stage, in a suitable building near the collocation (6 km). As well as the equipment to be tested, there is also the transferral of the simultaneous engineering team and the staff of the plant that will have to produce the new vehicle. This is the moment where the factory is closely involved in the development of the new model, when it begins to grasp a clear knowledge of the product and of the production process cycles. The presence of the workers of the productive plant during the pilot stage can be seen as a real training, that is not simply passive in that the representatives of the factory are specifically asked to test the equipment and propose changes to the process, and also to the product should it not be possible or economically feasible.
The crucial point arises during the passage from the pilot factory to the plant. A lot of the information gained by the men in production is insufficient because these men only represent a very small part of the whole production line.
(For more details on the involvement stage refer to point 2.2)

5.1. Is the degree of involvement satisfactory for the manufacturing people?

The improvement is due to three factors:
- the first concerns an earlier involvement with the men in production, right from the conception phases of the product. The process designers are not able to transfer all the know-how on production, especially for the carry over that will become greater and greater in future;
- the second factor is the extension of the development activities with the mass production activities, avoiding therefore a rigid sequencing of deliveries.
- the third factor, that is partly in process, is the transferral of the Process Manager involved in the core team of the Platform to the factory where the new model will be produced. In this case, the problem is that there are often several plants involved.

6. CAD/CAM Strategy

The development of the CAD/CAM systems has been given to the Systems and Computer Studies Department of Fiat Auto. The areas of Systems and Computer Studies range from the effective development of software to the definition of the architecture hardware and software, to the definition of the hardware and software configurations, also including the purchase of any instruments that are considered necessary.
50 internal specialists work to carry out this activity, alongside external consultants of varying numbers according to the needs.
Recently, for reasons of business focalization, Systems and Computer Studies has been separated from Fiat Auto and has given life to an autonomous company: Fiat Auto Mains. This company currently counts Fiat Auto as its main client, but it is beginning to offer its products and services to other companies within the Fiat Group and tertiary companies that belong, or do not belong, to Fiat induced activity.
The applicative support and the operational management of means have been assigned to support firms placed with the users. Recently, in this case too which was limited to the Technical Department, the management of means was separated and given to the Systems firm.

According to the people in charge at this company, on the whole the system used has turned out to match expectations and initial needs and is sufficiently suitable for the future ones. The next major developments will concern the acceptance of new applicative technologies (parametrical, variational and associational modelling), with an always greater push using CAM applications and the introduction of new methodologies of calculation planning.
The adopted architecture is structured on 3 levels:

a) Workstation with varied potential and configuration, dedicated to individuals or small groups of designers linked to each other and to second category servers, on a local network. The workstation is the place where CAD information is generated.
b) Servers, that group several workstations, run valuable peripherical units, such as plotters and magnetic units, as well as data of local interest, linking groups of workstations to the main network to which the Data base of common interest is linked.
c) Company Data Base, such as Master Data Base (MDB) that collects and keeps all the official and pre-official product data; the Raster Data Archive (ADR), that collects, runs and distributes all the product designs, CAD and manuals, in a "rasterised" way; the Suppliers Data Base (DBP) that runs the exchange of designs and mathematical models with the supplier of the induced activity; the Graphic Data Base (DBG) of the Technologies, that collects and organises the information produced by the technologies on the planning of the productive process.

All the Data Bases are linked by a high speed network. This way, the users that have the permission to link up, according to the predefined and controlled access method, can therefore exchange data among each other. Moreover, a link with the Distinct Base for the exchange of information regarding product structure is also operative.
The cluster server and workstation structure has been reproduced in a similar way at the decentralised Planning and Technologies sites (Arese, Pomigliano). Links with the central Data Bases are ensured by specific optic fibre lines at high speed. Every geographical area has a system for the preservation and back-up of the data Work in Progress (WIP).
As has already been stated, job organisation is carried out locally, whereas the organisation of the Central Data Base is directly carried out by the staff at System. The network is run and monitored by a team of people co-ordinated by System.
Official product data is stored in a structured and protected way in the Master Data Base (MDB). All the designers and technologists have access to the MDB, but with the authorisation to do different things: reading, writing and modifications, depending on the identified work needs.
All the technologists have access to MDB only for reading.
MDB is logically and physically centralised, in order to have evidently coherent data. However, as the planning sites are geographically located, it would be better to keep the centralisation solely at a logical level, with a decentralisation of the physics of the data.
This target will be reached as soon as the relational DB used offers sufficient guarantees of a correct management and alineation of data even in situations of potential error deriving from anomalies in the functioning of the network.
Technological data is stored in Data bases divided per area (mechanical, vehicle), with access limited the technological areas that generated it.
Data in process is stored, for back up reasons, in data bases divided per geographical area (WIP).
Despite the fact that the CAD model has been widely introduced, a traditional drawing board is always provided.
The adoption of simultaneous engineering means that the data is produced during the development of the procedures, and not exclusively at the end of them. Furthermore, having made parallel some of these activities, it is important for the updating to be continuous.
The results obtained thanks to CAD are transferred to the subsequent areas using models per surface, volume and lines with raster technology.
The diffusion of CAD instrumentation and methodologies has taken place primarily in sectors where CAD generated information could be used to carry out project, functional, assembly and installation checks, and where the mathematical models produced could be immediately used to

begin CN work, create prototypes using rapid prototyping techniques, define measurement paths for machines with automatic measuring and start up robots. This shows that the areas primarily affected by the diffusion of CAD have been the Planning and Technologies of bodywork, the Planning and Construction of models and dies, the Construction of style models and Testing.
Interventions on released designs take place in real time, simply by taking, on authorisation, the drawing from the Master Data Base.
Information on any changes made on the parts undergoing development must be given automatically, to allow all those working on that design to operate on an updated situation.
The introduction of CAD has changed the management of modifications, going from a push set-up, where whoever made the change informed the others, to a pull method, where whoever is directly involved requests the updating in progress. It is therefore always the responsibility of the designer to carry out or not the modifications to the part in question.
The complaints from those who receive CAD designs refer to the documentation of the parts, regardless whether they refer to the changes or the original project. On this subject, there has been a substantial increase in requests concerning the degree of detail and marginal information that were not considered really necessary under the old system. However, such complaints have little effect on the relations between the different partners in that the activity carried out in collocation makes communication and collaboration easier, unless there is a supplier who does not have the same automised procedure.
As far as the Bravo-Brava model is concerned, all the new part of the vehicle has been planned with CAD, both for the design and process planning. Only the carry over parts have been excluded, that have been developed with the technograph and some initial feasibility studies.
The distinction between the use of two or three dimensional models is very important. If on the one hand all the planning was made with a 3D system, on the other the 2D model was used when modelling was not required and the drawing had to be carried out quickly. The designer must use his experience to decide which system is the most suitable.
In the future, the CAS system will be widely used on the vehicles, so as to begin right from the sketches.

6.1 Training intervention

A good knowledge of the instrument used is essential to be able to obtain a complete use of the functions on offer. However, a good training in the methodologies that are considered the most suitable for the development of CAD planning is equally important.
In Fiat Auto, training times depend on the different technologies and methodologies used: for two dimensional CAD drawing one week's truing is sufficient; for three dimensional CAD modelling four week are necessary, spread out in such a way as to leave sufficient time, between two modules, for consolidation on site, by means of operative stages, of the concepts learnt. Courses for bosses are also planned, lasting one week. Updating is supplied in different ways, that are defined each time, on the basis of real necessities and the type of updating required (new release, new functions and new methodologies).
Cost purposes and the necessity to adapt the training as much as possible to company needs have made it advisable to run the organisation and management of the CAD courses within the Fiat Group (Isvor).
The introduction of a new professional role has been devised to enable a correct and efficacious learning of CAD techniques.
In fact, for about two years now, around 50 designers have been given the task of dedicating circa 20% of their time to the training and support of the newly-qualified CAD designers. This professional, called "innovation diffuser", has the job of working with the teacher during the consolidation phase, so that the young designers can have a tutor as their reference point.

Other professionals work alongside the diffusers: the application engineers whose job is mainly to support the correct use of the instruments, applicative hardware and methodologies used.
The presence of diffusers and applications shows that theoretical learning is insufficient when facing the instrumental and methodological complexity of the CAD planning of a vehicle.
To obtain full use of CAD, a period of work activity is necessary, that can vary from few weeks, in less complex cases, to many months in the case of the planning of very complex parts.

6.2. CAD/CAM Integration

According to CAD/CAM representatives, the greater problem in the process chain from concept to production start-up is the insufficient process chain thinking, the insufficient data quality and the department structure.
Lack of uniformity in the documentation, qualifications problems, lack of acceptance of CAD and holding back information in order to optimize one's own work were rated at medium level.
Incompatibilities between operating systems, hardware and software, system defect and breakdowns, technical interface problems do not create problems at all.

6.3. Data transfer with suppliers and problems

In order to continue the improvement of the integration of suppliers in the "Fiat Auto system", as an integral part of the CAD/CAM company development plan, a supplier development plan has also been devised.
This plan aims at ensuring that the substitution of the traditional planning and design in Fiat Auto with CAD does not have its impact on an unprepared supplier group, but favours a development that is parallel to and coherent with the company one.
Firstly a CAD/CAM supplier data bank has been set up, where all the suppliers who have one, their hardware and software organisation, dedicated resources and type of the activities developed with CAD are recorded.
Particular attention must be paid to suppliers in co-design for whom the possibility of a network link with the data base of the Cad Planning drawings is planned; they must be as homogenous with the company system as possible.
An initial group of suppliers belonging to the Fiat Group can have direct access to the central MDB, with the same procedures as the internal Fiat Auto users, organised and controlled by information access authorisations.
Suppliers external to the Fiat Group can have access only via a specific data base (DBF), that operates like an intelligent box number, that filters and endorses the operations carried out on identification of the supplier. Two procedures are used: if the supplier has been certified, he can operate directly on the MDB, even if it is filtered by the DBF; should the supplier not be certified, the transferral of the information from MDB to DBF and vice versa, is activated by an internal designer as well as being filtered by authorisations.
The link with the supplier can take place via a data transmission line (12 suppliers are currently linked, one of whom in Japan), or via a magnetic support (magnetic tape).
In all the above-mentioned situations, as well as for internal information exchanges, a standard definition and structuration and formatting of data rules are essential, to ensure the use of, and a correct interpretation by all the users involved, whether they be internal or external. Seven integration levels have been devised on this subject, that outline the rules and interexchange procedures from the physical transportation of the data to Cad planning methods.

7. Personnel Development System

7.1 Incentives

There are contractual and discretionary incentives.
The classic incentives established by contract, such as production bonuses and performance incentives which have both been regulated since the 70's, are being eliminated basically because they incur high costs and produce little incentive due to their limited variability and effect on pay.
The performance group bonus (PGB) on the other hand, will become more and more important. One part of the bonus is variable and the other fixed. PGB was the first attempt to link one part of pay to company results (reference to company trend) even if its reference to the entire trend of the whole group does not show a relationship between individual contribution and remuneration.
In the case of Melfi, a new system of contractual incentives that will have a much higher effect on salaries, around 10% of the annual pay, will be tried out with the trade unions. The evaluation method will be much more objective and will be based on three indicating factors, chosen on a pre-defined scale of seven variables at the level of plant, productive unity, and team work. This way the relationship between team work, management results and pay will be enhanced.
Discretionary incentives can be equated with pay rises - grants and Una Tantum. They are managed openly and take into consideration the evaluation of performance according to the different levels, objectives reached and projects achieved. The bonus is personal, but with the present tendency to work in teams it is possible to hypothesise the development of a bonus system that rewards the results of small groups.
The same system exists for the manual workers, though they have different contents and ways. The bosses also receive a premium at the end of the year, even considering the fact that the category is excluded by contract from the payment of overtime.

7.2 Job rotation

The staff development program is defined centrally by the company, using specific programs of job rotation within the general policies of the Personnel Department. However, they must not be considered as being a systematic factor to be openly followed. Usually, rotation is greater within the purchasing areas and experimentation.
There is no tendency to deviate rotation or hinder the insertion of workers coming from other departments. In fact, all the departments interviewed stated that rotation is considered to be professionally constructive, and that the company must increase the amount of job rotation.
There are no incentives to favour rotation.
With the formulation of platforms, staff rotation has in fact increased. Human resources go from the functional areas to the different platforms, and then return. Therefore it is possible, for example, for a worker belonging to a certain area to spend at first a certain period of time there, and then be placed temporarily in a platform, return to his area and then be placed within yet another platform. Thus rotation takes place, but primarily between the platforms, where the work methods in simultaneous engineering undoubtedly produce a great improvement in the degree of professionality.
An expert on engineering know-how has been placed within the functional framework, with the role of defining the level of know-how required, finding out the existing level of know-how and carrying out operative plans of professional growth.

Because of new company needs, we are moving towards a flat type of organisational structure, where vertical growth possibilities are more limited but where the lateral passages necessary to enrich professional skills that must become more and more systematic take on importance.
The reduction of hierarchical levels makes it compulsory to carry out worthwhile evaluations on elements that are less tangible, making the management of human resources more sophisticated objectively. The taking on of responsibility and becoming autonomous or the achievement of real qualitative improvements (professional skills) are elements that are difficult to quantify compared to the reaching of productive aims.
There is therefore a more and more widespread presence in work organisation of experts that have responsibility for the management of a part of a process, with different professional roles and tasks that are not pre-defined but basically aimed at the diagnosis and prevention of process anomalies, interacting completely with the team that has the responsibility for the particular process.
On the other hand, the general manual worker is also moving away from tasks that involve a merely passive execution, becoming an absorbing element in the micro-variances that results in the concept of self-assessment of one's work. Therefore a progressive plan has been set up that takes into consideration several productive units.

7.3 Improvement programs

1) Quality circles.
They were started in 1982. Now there are almost 450 with about 4000 workers involved in productive levels (around 10% of the people potentially interested) and an average life-span of around one and a half years per circle. The reference model in the Japanese one, and the team leader is the head of the elementary technological units (UTE). The quality circles are completely self-managed. None of the solutions are rewarded economically. The main consequence has been the change within the company climate, if we consider that in the 80's the firm launched a staff involvement program after a period of severe internal difficulties.

2) Cedac.
Poor result. It is basically a problem solving instrument with the possibility of receiving proposals and advice from everyone. It has not been accepted at top levels and by the structures. It has not allowed the technicians to go onto the shop-floor.

3) Quality Improvement Proposals
At production level, the improvement proposals referring to quality, costs, ergonomics and materials, receive a reward that increases with the number of proposals, should they be accepted.
Results have been very positive with a progressive growth of interest. There is a technical problem, especially if planning/Suppliers are affected. If the proposal is selected within each UTE, it is the same unit that decides any future change on the basis of the budget available.

4) Omega groups
Another improvement tool is made up of the Omega interfunctional groups for the perfectioning of the product in question. The omega groups involve all the company areas such as Technologies-Factory-Marketing-Experimentation within the improvement process of the product. At the moment they are co-ordinated by those in charge of the Quality of each model.
At a planning level, there are incentive programs in the Technical Department, such as Faber Idea, which is basically a monthly competition with prizes.

7.4 Procedure for Recruiting

There is a close relationship with the Universities, and pre-evaluations are carried out in the Polytechnics that can lead to the assignation of study grants. If there is a positive demand cycle, employment can be given by direct contact by letter.
A certain period of time in production is not necessary. Each graduate is placed according to the organisational needs and personal capacities in the functions of specific placement.
Over the last few years there has been no new employment of staff within the Technical Department. Staff replacement has taken place by the transferral of staff from the Fiat Research Centre.

7.5 Working time

Production is organised in 2 or 3 shifts, whereas technicians only work one main shift.
Some members of staff work shifts in the technical department, but there are very few of them. One shift only has been chosen for CAD, even though the great financial investment involved would make it more obvious to make more use of the equipment. In this case, the problems connected with staff management were considered over-riding.

7.6 Job specialisation

Task assignment often follows specialisation criteria. In fact, high evaluation is assigned when:
- They fill a position, they often specify the qualification for a job as exactly as possible in order to find the right person.
- They share the work according to its degree of difficulty and assign it to the corresponding qualification group. Know-how is always safe-guarded.
- They connect formal education and work assignment.

They occasionally pursue:
- the connection between the same workers with the same tasks in order to improve experience.
- The division of work when someone has become especially proficient in a particular work area in order to assign him/her these tasks as much as possible.

Figure 1: Fiat Auto new model development

	SEG. A	SEG. B	SEG. C	SEG. D	SEG. E	OTHERS
1992	Fiat 500			Alfa R. 155		
1993		Fiat Punto	Fiat Tipo 3p Lancia Delta			
1994		Fiat Punto Cabrio	Fiat Coupè Alfa R. 145	Lancia Dedra SW	New Lancia Thema	Monovolume
1995		Lancia Y11 Alfa R. Spider	Alfa R. 146 New Fiat Tipo			Spider Fiat
1996				New Fiat Tempra	New Alfa R. 164	
1997					New Fiat Croma	

Figure 1: Fiat Auto new model development

	Fiat 500	Alfa R. 155				
1992						
1993		Fiat Punto	Fiat Tipo 3p			
			Lancia Delta			
		Fiat Punto Cabrio	Fiat Coupe	Lancia Dedra SW	New Lancia Thema	Maxivolume
1994						
			Alfa R. 145			
		Lancia Y11	Alfa R. 146			Spider Fiat
1995		Alfa R. Spider	New Fiat Tipo			
1996		New Fiat Tempra	New Alfa R. 164			
1997		New Fiat Croma				

Figure 2: Phases and milestones of the Product Development Process

Figure 2: Phases and milestones of the Product Development Process

PHASES		
PRODUCT PLANNING	12 Months	ARCHETYPE
DESIGN	6 Months	BRIEFING
ENGINEERING	12 Months	FEASIBILITY STUDY
EQUIPMENT CHECK-OUT	6 Months	STAGE APPROVAL
PRE-PRODUCTION RUN-UP	4 Months	PRODUCTION MASS
	6 Months	RESOLUTION PRODUCTION
		RESOLUTION PRODUCT
	12 Months	RESOLUTION PERFORMANCE
		SPENDING
		LAUNCHING PRODUCT

Figure 3:MILESTONES ACTIVITIES

ARCHETYPE

INTEFUNCTIONAL CORE TEAM SETTING (LEAD BY MARKETING)

BRIEFING

APPROVAL OF THE DEVELOPMENTS OF THE ARCHETYPE'S CONCEPTS

FEASIBILITY STUDY

START OF DESIGN AND ENGINEERING PARTS NO TIED TO STYLE
FIRST INTERFUNCTIONAL TEAMS SETTING UP

STYLE APPROVAL

START OF DESIGN AND ENGINEERING PARTS TIED TO STYLE
CORE-TEAM LEAD BY PLATFORM DIRECTOR
START OF CODESIGN

SPENDING

APPROVAL OF INVESTMENTS
PILOT PRODUCTION
TESTS ON PROTOTYPE

PERFORMANCE RESOLUTION

START OF CHECK OUT EQUIPMENT
RELIABILITY TESTS

PRODUCT RESOLUTION

START OF PRE-PRODUCTION
TRANSFER OF THE TEAMS TO THE FACTORY
PRODUCT ANNOUNCEMENT

PRODUCTION RESOLUTION

START OF RUMP-UP

MASS PRODUCTION

2/3 PRODUCTION CAPACITY

Figure 3:MILESTONES ACTIVITIES

ARCHETYPE

INTERFUNCTIONAL CORE TEAM SETTING (LEAD BY MARKETING)

BRIEFING

APPROVAL OF THE DEVELOPMENTS OF THE ARCHETYPE'S CONCEPTS

FEASIBILITY STUDY

START OF DESIGN AND ENGINEERING PARTS NO TIED TO STYLE
FIRST INTERFUNCTIONAL TEAMS SETTING UP

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APPROVAL OF INVESTMENTS
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TRANSFER OF THE TEAMS TO THE FACTORY
PRODUCT ANNOUNCEMENT

PRODUCTION RESOLUTION

START OF RUMP-UP

MASS PRODUCTION

%3 PRODUCTION CAPACITY

Figure 4: Design Review System in Fiat Auto

M.S.D.R.
Management System Design Review

0 **Plan Targets Review**: after product briefing.

1 **Global Planning Review**: after feasibility study.

2 **Project Requirements Review**: before style approval.

3 **Project Development Review**: after chassis approval and before first prototype.

4 **Experimental Stage Review**: after first prototype batch.

5 **Final Project Review**: after second prototype batch.

6 **Process Capability Review**: after check-out equipments.

7 **Industrial Process Review**: after pre-production.

8 **Review Production Start**: before rump-up.

Figure 4: Design Review System in Fiat Auto

Figure 5: Fiat Auto: R&D Structure

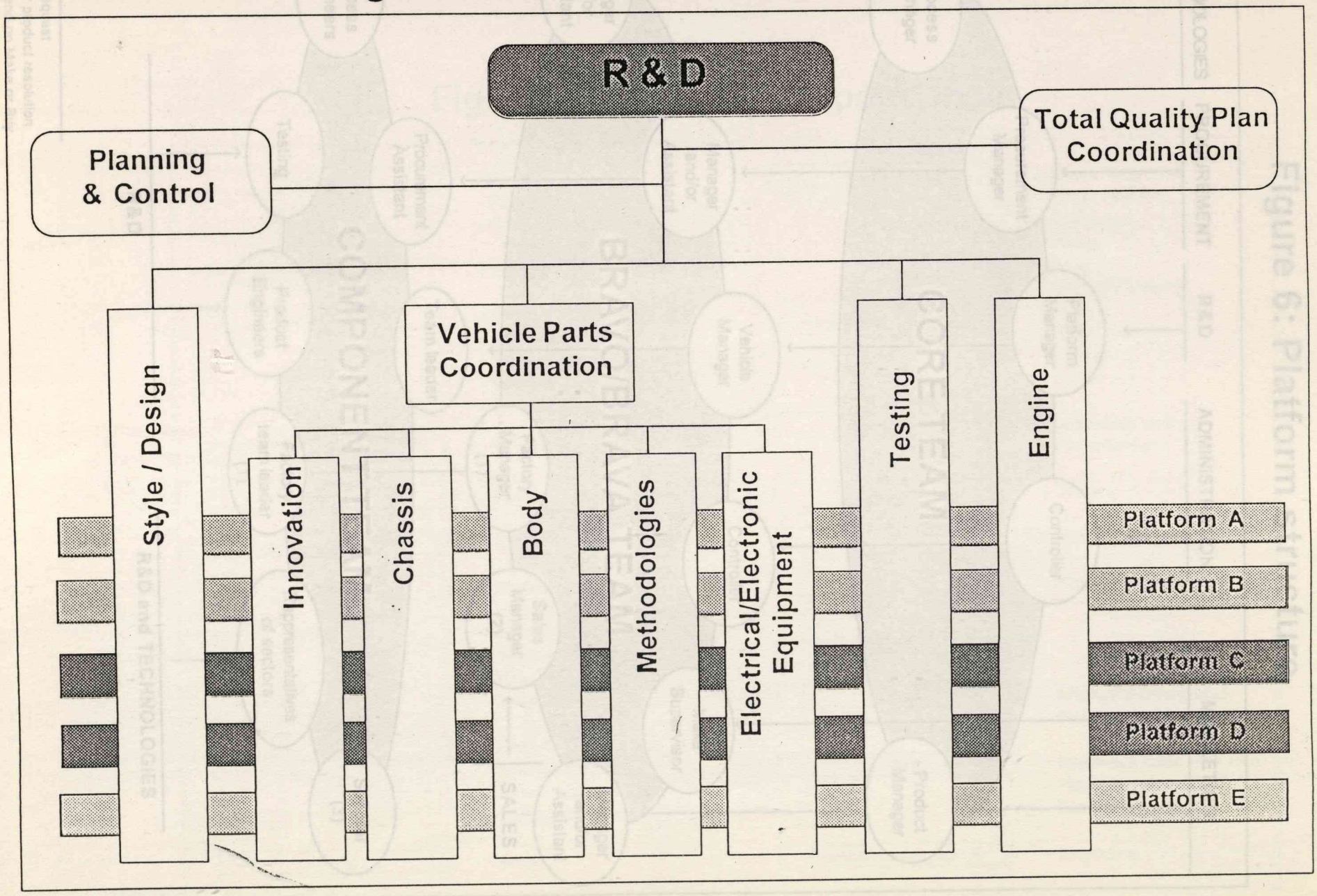
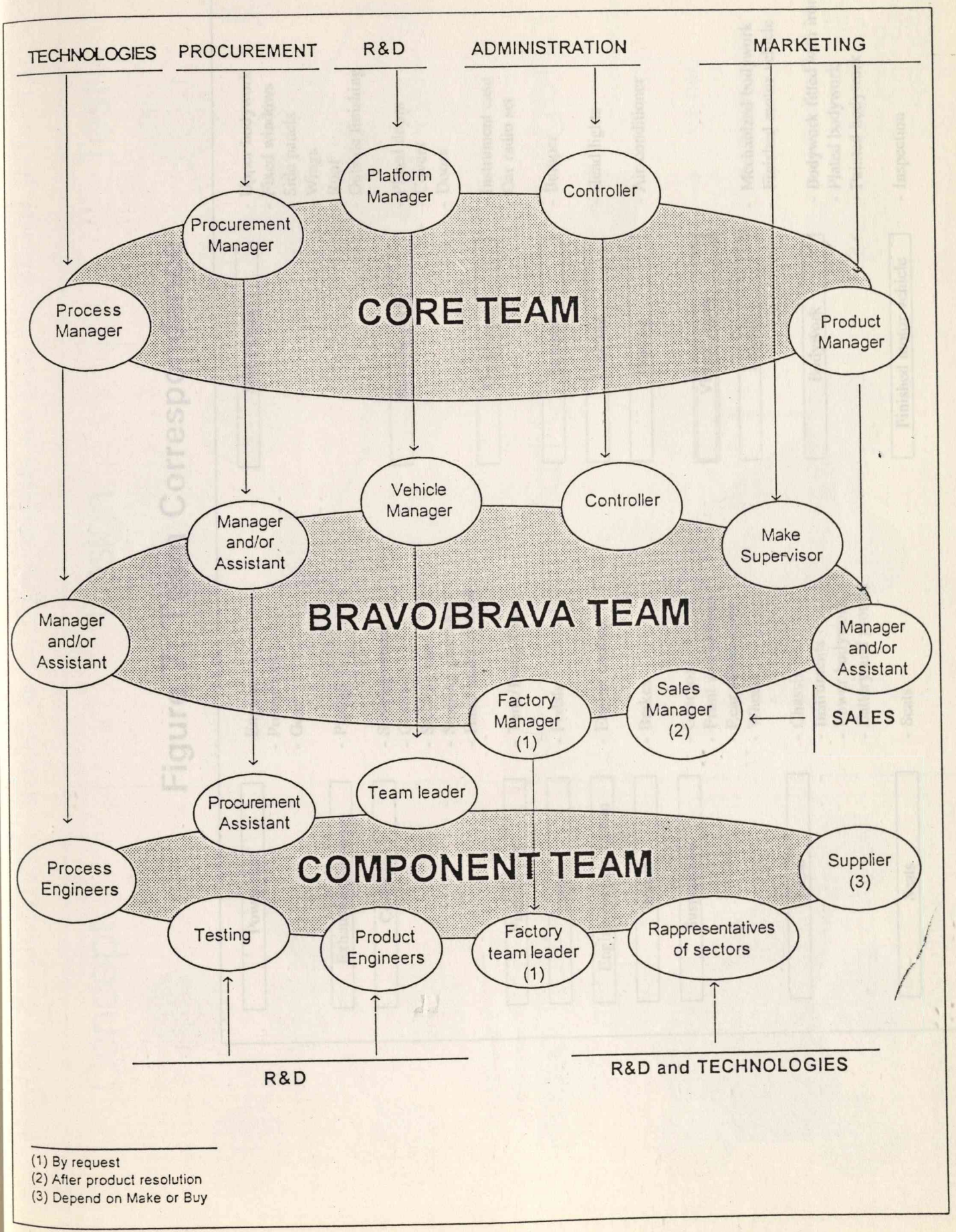


Figure 5: Fiat Auto: R&D Structure

Figure 6: Platform structure



(1) By request
(2) After product resolution
(3) Depend on Make or Buy

Figure 6: Platform structure

(1) By request
(2) After product resolution
(3) Depend on Make or Buy

Figure 7: Team Correspondence

Power unit	- Engine - Power unit - Gear
Exhausting/Suction	- Pipings
Controls	- Steering wheel - Gearbox - Steering case - Steering gear shaft - Hand brake control
Fuel supply	- Tank/Pump/Filter
Pedals	- Pedals
Engine cooling system	- Engine cooling
Brakes	- Brakes
Suspensions	- Gearbox - Front suspensions - Rear suspensions - Wheels
Flatcar	- Chassis - Instruments - Lower bodywork - Battery and ground
Seats	- Seats
Side panels	- Upper bodywork - Fixed windows - Side panels - Wings - Roof - Outside finishing
Movable parts	- Plated doors - Covers - Doors
Dashboard	- Instrument case - Car radio set
Bumper	- Bumper
Lighting	- Head lights
Heating	- Air-conditioner
Virtual teams	
Layout	- Mechanized bodywork - Finished motor vehicle
Bodywork	- Bodywork fitted with iron - Plated bodywork - Painted bodywork
Finished motor vehicle	- Inspection

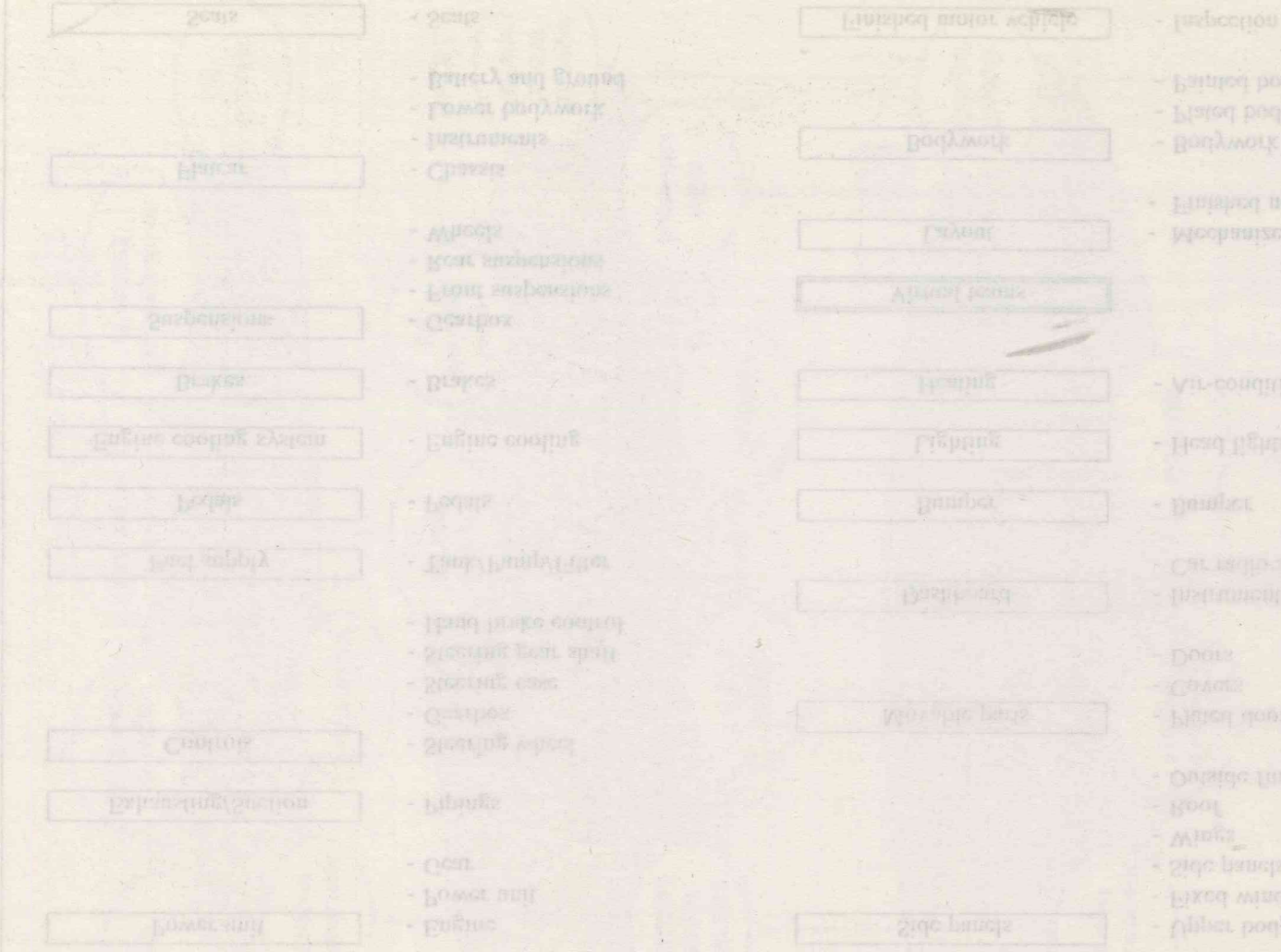


Figure 7: Team Correspondence

Figure 8: Comunication & cooperation in the internal process chain

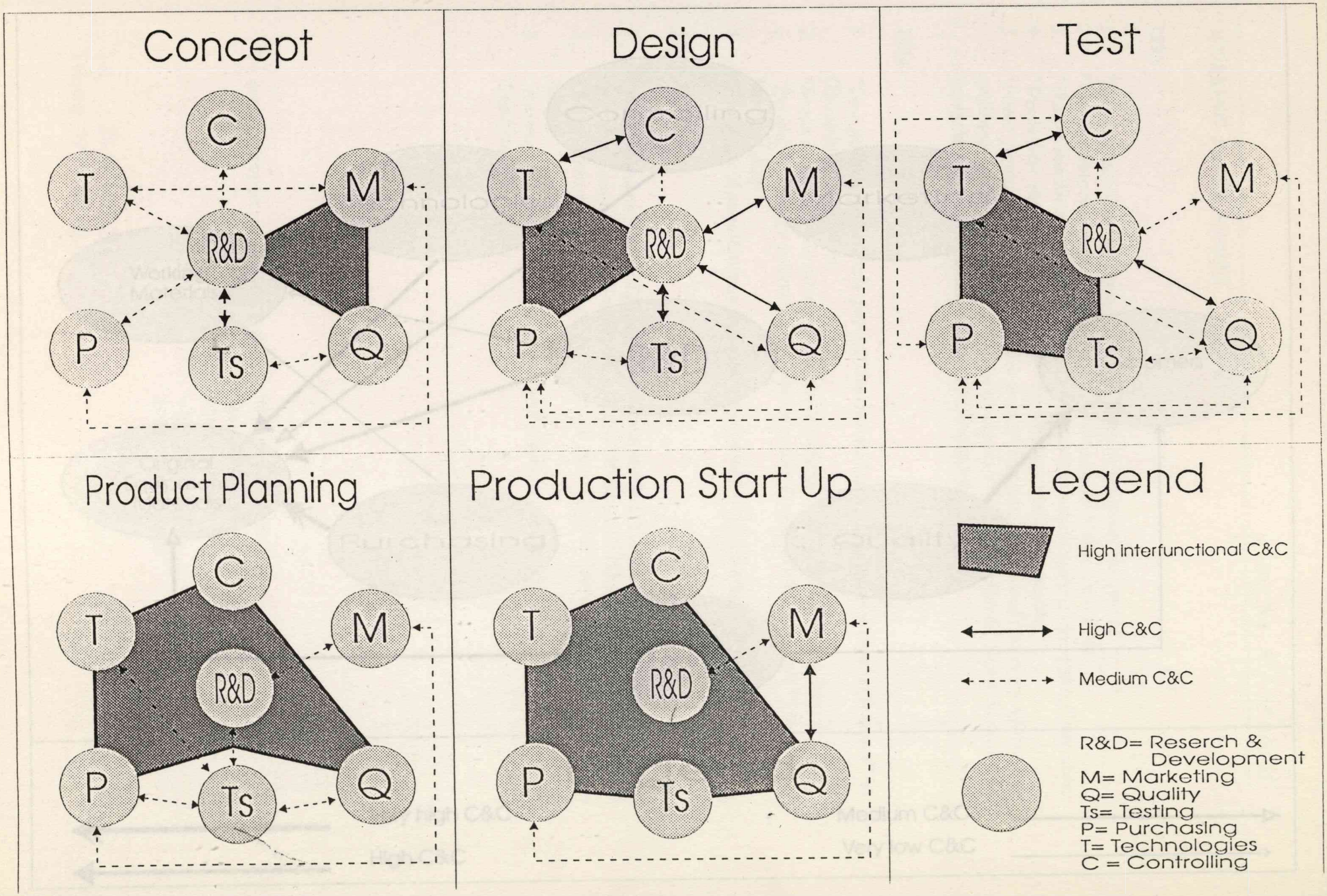
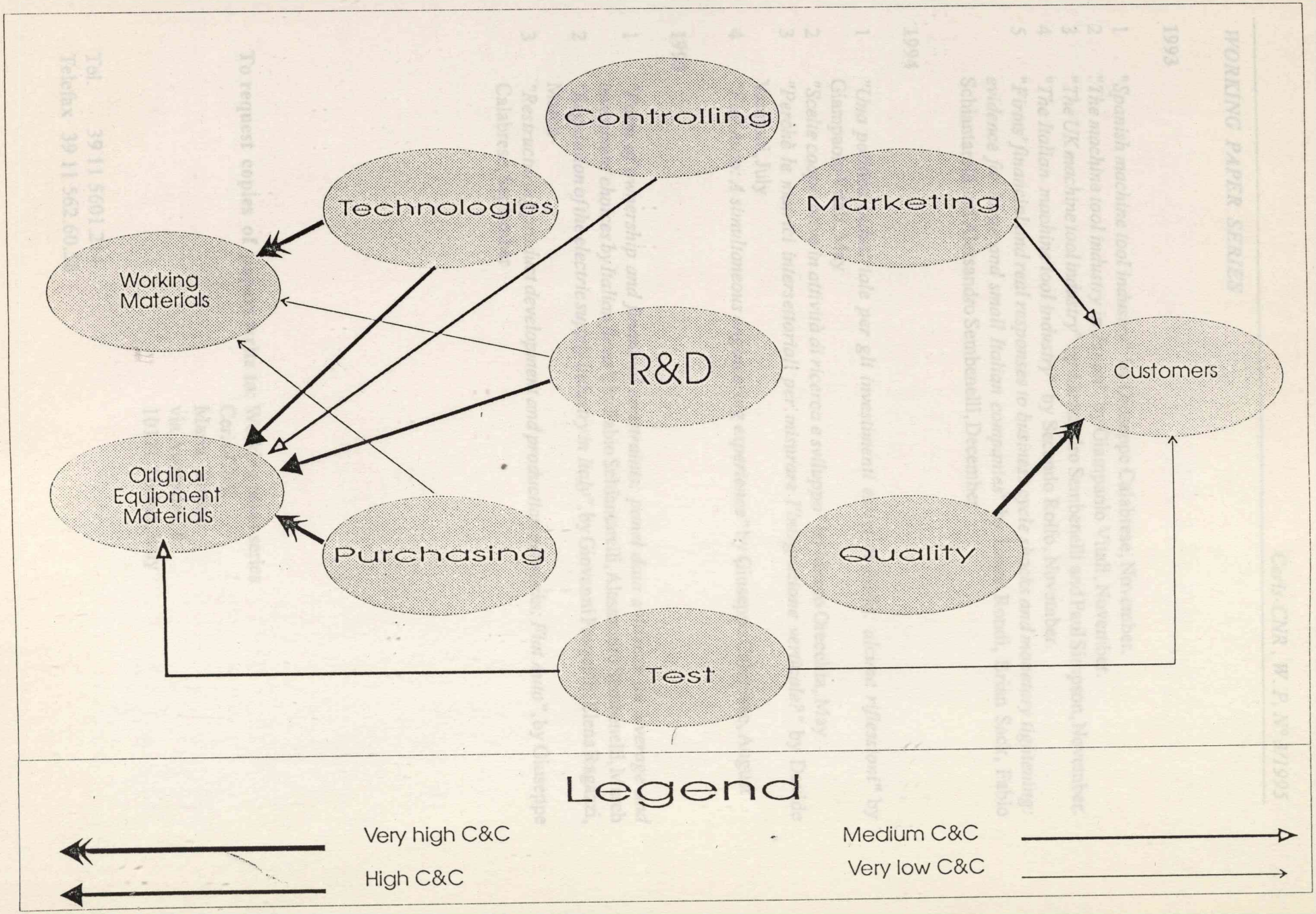


Figure 6: communication & collaboration in multifunctional process cluster

Figure 9: Communication & cooperation in the external process chain



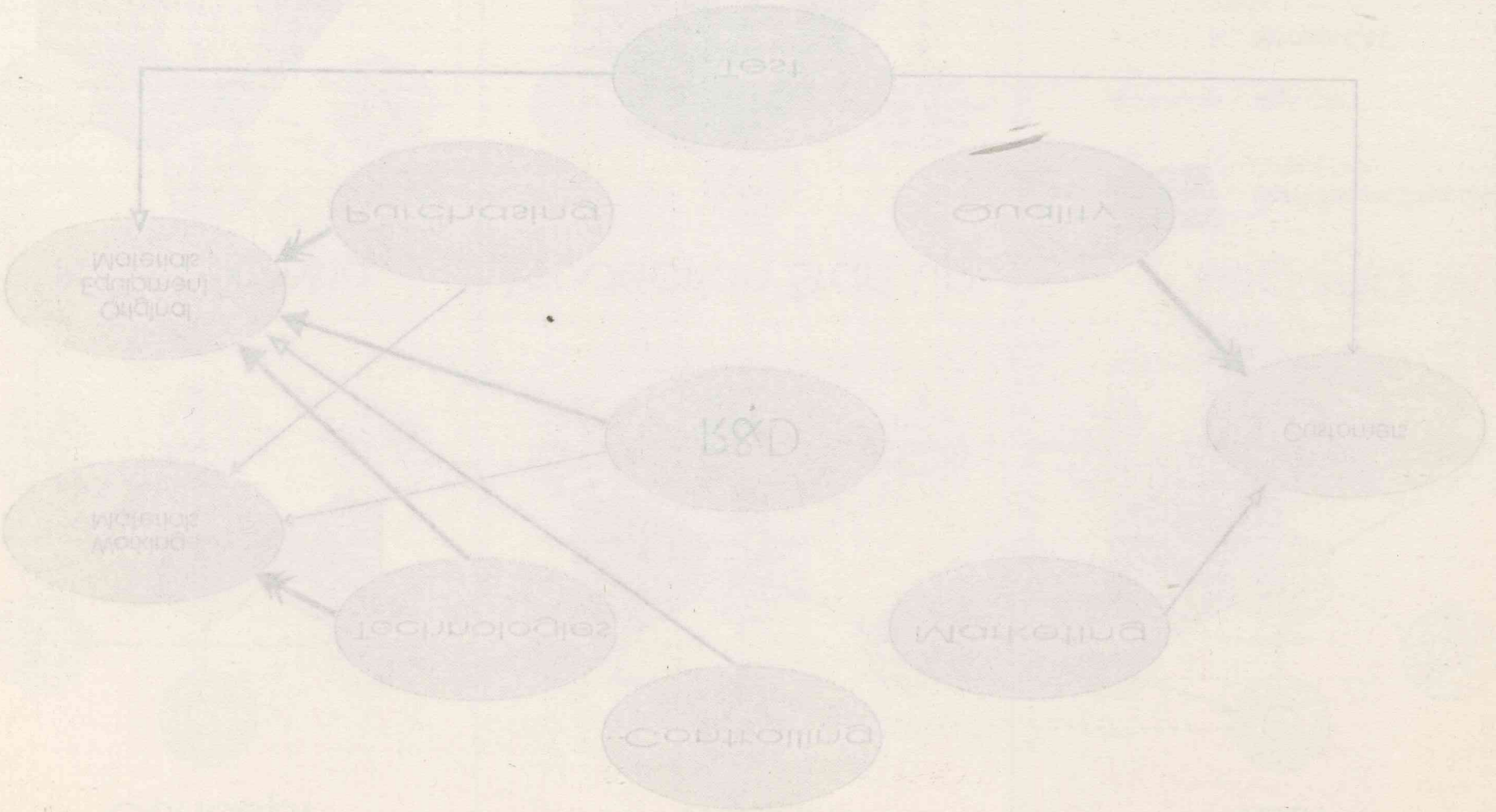


Figure 3: Communication & cooperation in the external process chain

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